



## An Assessment of Low-Pressure Crude Oil Pipelines and Gathering Lines

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### Chapter 3 Background Pipeline Risk Data

A number of sources are available for pipeline incident data. Unfortunately, few of them include the reliable pipeline inventory necessary to determine meaningful incident rates. In this Chapter, we have presented results from the following sources:

- ! CONCAWE Oil Pipelines Management Group's Special Task Force on Pipeline Spillages (OP/STF-1). Performance of Oil Industry Cross Country Pipelines in Western Europe, Statistical Summary of Reported Spillages. 1981 to 1994 annual reports.
- ! Line Pipe Research Supervisory Committee of the Pipeline Research Committee of the American Gas Association. An Analysis of Reportable Incidents for Natural Gas Transmission and Gathering Lines 1970 Through June 1984, NG-18 Report Number 158. 1989.
- ! Line Pipe Research Supervisory Committee of the Pipeline Research Committee of the American Gas Association. An Analysis of DOT Reportable Incidents for Gas Transmission and Gathering Pipelines for June 1984 Through 1992, NG-18 Report Number 213. 1995.
- ! United States Department of Transportation, Research and Special Programs Administration, Office of Pipeline Safety. Annual Report on Pipeline Safety. 1986 through 1992 annual reports.

Each of these reports provide pipeline incident data for *reportable* incidents. However, the criteria for *reporting* incidents differs for each study. This makes direct comparison of the individual results difficult. On the other hand, it provides a methodology for estimating incident rates for spills meeting various criteria.

The following subsections provide a summary of the data contained in each of these reports. The incident rates are shown in units of *incidents per 1,000 mile years*. This unit provides a means for predicting the number of incidents expected for a given length of line, over a given period of time. For example, if one considered an incident rate of 1.0 incidents per 1,000 mile years; one would



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expect one incident per year on a 1,000 mile pipeline. If the pipeline was only one mile long, one would expect 1/1,000th of an incident per year, or an incident every 1,000 years. Using these units, frequencies of occurrence can be calculated for any pipeline length and/or time interval.

### 3.1 CONCAWE - 1981 Through 1994

We have summarized the pipeline results for western European pipelines, as presented in the CONCAWE Performance of Oil Industry Cross Country Pipelines In Western Europe, Statistical Summary of Reported Spillages, 1981 through 1994 annual reports in Table 3-1.

The criteria for including hazardous liquid pipeline incidents in these reports are as follows:

- ! all spills greater than one cubic meter (approximately 264 gallons or 6 barrels) and
- ! spills less than one cubic meter, if the spill had a noteworthy impact on the environment.

The reader should note that only onshore pipelines were included in these data. Also, beginning in 1994, non-commercially owned pipelines began to be included in the database.

It is interesting to note that this reporting criteria does not include any consideration for incidents which cause injuries and/or fatalities. As a result, the injury and fatality incident rates derived from this data may be low. Also, the overall incident rates for these relatively large spills are comparatively low, as shown below:

Incident Rate (per 1,000 mile/years)	.850
Injury Rate (per 1,000 mile/years)	.006
Fatality Rate (per 1,000 mile/years)	.018



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Table 3-1  
**European Hazardous Liquid Pipeline Incidents**  
as Reported by CONCAWE  
1981-1994

	1981	1982	1983	1984	1985
Total Pipeline Mileage	11,737	11,364	11,240	10,743	10,805
Number of Incidents	16	10	10	13	7
Incident Rate (Incidents/1000 Mile Years)	1.36	.88	.89	1.21	.65
Number of Injuries	0	0	0	0	0
Injury Rate (Injuries/1000 Mile Years)	.000	.000	.000	.000	.000
Number of Fatalities	0	0	0	0	0
Fatality Rate (Fatalities/1000 Mile Years)	.000	.000	.000	.000	.000

	1986	1987	1988	1989	1990
Total Pipeline Mileage	10,805	10,805	10,992	11,737	12,024
Number of Incidents	12	8	11	13	4
Incident Rate (Incidents/1000 Mile Years)	1.11	.74	1.00	1.11	.33
Number of Injuries	0	0	0	1	0
Injury Rate (Injuries/1000 Mile Years)	.000	.000	.000	.085	.000
Number of Fatalities	0	0	0	3	0
Fatality Rate (Fatalities/1000 Mile Years)	.000	.000	.000	.256	.000

	1991	1992	1993	1994	Total
Total Pipeline Mileage	13,049	13,359	13,422	19,138	171,220
Number of Incidents	14	7	10	11	146
Incident Rate (Incidents/1000 Mile Years)	1.07	.52	.75	.57	.85
Number of Injuries	0	0	0	0	1
Injury Rate (Injuries/1000 Mile Years)	.000	.000	.000	.000	.006
Number of Fatalities	0	0	0	0	3
Fatality Rate (Fatalities/1000 Mile Years)	.000	.000	.000	.000	.018

Reportable incidents include:

1. All leaks greater than one cubic meter (264 gallons or approximately 6 barrels)
2. All leaks under one cubic meter which result in noteworthy environmental impact



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### 3.2 U.S. Natural Gas Transmission and Gathering Lines - 1970 Through June 1984

Table 3-2 presents the reportable domestic natural gas transmission and gathering line incidents from 1970 through June 1984. Although this data is for natural gas lines, instead of crude oil lines which are the subject of this study, the data is worth noting for comparison. These natural gas transmission lines are of similar construction to the steel pipelines included in this study.

The criteria for leaks to be reported to the USDOT for inclusion in this data are as follows:

- ! resulted in a death or injury requiring hospitalization,
- ! required the removal from service of any segment of a transmission pipeline,
- ! resulted in gas ignition,
- ! caused an estimated damage to the property owner, or of others, or both, of \$5,000 or more,
- ! involved a leak requiring immediate repair,
- ! involved a test failure that occurred while testing either with gas or another test medium, or
- ! in the judgement of the operator, was significant even though it did not meet any of the above criteria.

The incident rates for reported leaks meeting this criteria are summarized below:

Incident Rate (per 1,000 mile/years)	1.300
Injury Rate (per 1,000 mile/years)	.096
Fatality Rate (per 1,000 mile/years)	.016



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Table 3-2  
**U. S. Natural Gas Transmission and Gathering Lines**  
1970 - June 1984

	1970	1971	1972	1973	1974	1975
Total Pipeline Mileage	284,196	285,482	285,575	285,241	293,885	267,079
Number of Incidents	343	409	409	471	458	366
Incident Rate (Incidents/1000 Mile Years)	1.21	1.43	1.43	1.65	1.56	1.37
Number of Injuries	24	24	37	19	21	21
Injury Rate (Injuries/1000 Mile Years)	.084	.084	.130	.067	.071	.079
Number of Fatalities	1	3	6	2	4	7
Fatality Rate (Fatalities/1000 Mile Years)	.004	.011	.021	.007	.014	.026

	1976	1977	1978	1979	1980
Total Pipeline Mileage	277,555	283,373	303,355	311,098	388,857
Number of Incidents	254	445	444	482	325
Incident Rate (Incidents/1000 Mile Years)	.92	1.57	1.46	1.55	.84
Number of Injuries	42	22	30	96	16
Injury Rate (Injuries/1000 Mile Years)	.151	.078	.099	.309	.041
Number of Fatalities	7	8	1	12	1
Fatality Rate (Fatalities/1000 Mile Years)	.025	.028	.003	.039	.003

	1981	1982	1983	1984;	Total
Total Pipeline Mileage	400,243	342,645	346,355	157,921	4,512,860
Number of Incidents	389	390	473	204	5,862
Incident Rate (Incidents/1000 Mile Years)	.97	1.14	1.37	1.29	1.30
Number of Injuries	6	41	25	11	435
Injury Rate (Injuries/1000 Mile Years)	.015	.120	.072	.070	.096
Number of Fatalities	6	10	2	2	72
Fatality Rate (Fatalities/1000 Mile Years)	.015	.029	.006	.013	.016

NOTES: 1. 36 of the total 72 fatalities were to employees of the operating company  
2. 161 of the total 274 injuries were to employees of the operating company  
3. 1984 mileage figure shown is 2 actual mileage to account for only 2 year of data

Reportable incidents includes:  
1. Resulted in a death or injury requiring hospitalization  
2. Required the service outage of any segment of a trans line  
3. Resulted in gas ignition or leak requiring immediate repair  
4. Caused an estimated damage to property of \$5,000 or more  
5. Involved test failure while testing with gas or other media  
6. Was significant though it did not meet any of the above criteria



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### 3.3 U.S. Natural Gas Transmission and Gathering Lines - June 1984 through 1992

Table 3-3 presents the reportable domestic natural gas transmission and gathering line incidents from June 1984 through 1992. It is important to note that in June 1984, the USDOT changed the criteria for reporting leaks. The most significant change was that in general, leaks causing less than \$50,000 property damage, did not have to be reported. Since this value is significantly greater than the \$5,000 criteria for the earlier study period, we see a significant decrease in the resulting *reportable* incident rate. Although impossible to verify using this data, we also believe that the actual frequency of incidents decreased during this period as a result of one-call system implementation, among other things.

The criteria for leaks to be reported to the USDOT from June 1984 through 1992 were as follows:

- ! Events which involved a release of gas from a pipeline, or of LNG or gas from an LNG facility, which caused: (a) a fatality, or personal injury necessitating inpatient hospitalization; or (b) estimated property damage, including costs of gas lost by the operator, or others, or both, of \$50,000 or more.
- ! An event which resulted in an emergency shut-down of an LNG facility.
- ! An event that was significant, in the judgement of the operator, even though it did not meet the criteria above.

The incident rates for reported leaks meeting this criteria from June 1984 through 1992 are summarized below:

Incident Rate (per 1,000 mile/years)	.260
Injury Rate (per 1,000 mile/years)	.061
Fatality Rate (per 1,000 mile/years)	.018

As demonstrated by the approximately 80% reduction in the incident rate over the earlier period, we see that the change in reporting criteria, among other things, had a major influence on the results. However, it is interesting to note that the injury and fatality rates remained nearly unchanged from the earlier period.



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Table 3-3  
**Onshore U. S. Natural Gas Transmission and Gathering Lines**  
June 1984 through 1992

	1984	1985	1986	1987	1988
Total Pipeline Mileage	157,921	324,426	340,202	290,176	310,079
Number of Incidents	82	115	77	59	80
Incident Rate (Incidents/1000 Mile Years)	.52	.35	.23	.20	.26
Number of Injuries	32	12	20	15	13
Injury Rate (Injuries/1000 Mile Years)	.203	.037	.059	.052	.042
Number of Fatalities	7	6	6	0	3
Fatality Rate (Fatalities/1000 Mile Years)	.044	.018	.018	.000	.010

	1989	1990	1991	1992	Total
Total Pipeline Mileage	313,751	294,504	315,290	327,484	2,673,833
Number of Incidents	83	72	65	52	685
Incident Rate (Incidents/1000 Mile Years)	.26	.24	.21	.16	.26
Number of Injuries	28	17	12	15	164
Injury Rate (Injuries/1000 Mile Years)	.089	.058	.038	.046	.061
Number of Fatalities	22	0	0	3	47
Fatality Rate (Fatalities/1000 Mile Years)	.070	.000	.000	.009	.018

NOTES: 1. 1984 mileage figure shown is **2** actual mileage to account for only **2** year data

Reportable incidents include:

1. Events which involve a release of gas from a pipeline, or of LNG or gas from a LNG facility which cause
  - a. a fatality or personal injury requiring inpatient hospitalization
  - b. an estimated damage to property of \$50,000 or more
2. Events which resulted in an emergency shutdown
3. Events which were significant though it did not meet any of the above criteria



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### 3.4 U.S. Hazardous Liquid Pipeline Accidents - 1986 through 1992

As noted earlier, a reliable pipeline inventory is necessary to determine precise incident rates. The degree of accuracy of the domestic hazardous liquid pipeline inventory is questionable. For example, the total reported pipeline length remained constant for each year examined. However, we are aware of new line construction and line abandonments during this period. As a result, *we believe that the incident rates derived using the reported pipeline lengths are approximations only*; they should not be taken as absolute.

Table 3-4 presents the reportable domestic hazardous liquid pipeline incidents from 1986 through 1992. The criteria for incidents to be reported to the USDOT for inclusion in this data were as follows:

- ! explosion or fire not intentionally set by the operator,
- ! loss of more than 50 barrels of liquid or carbon dioxide,
- ! escape to the atmosphere of more than five barrels per day of highly volatile liquid,
- ! death of any person,
- ! bodily harm to any person resulting in loss of consciousness, necessity to carry the person from the scene, or disability which prevents the discharge of normal duties or normal activities beyond the day of the accident, and/or
- ! estimated property damage to the property of the operator, or others, or both, exceeding \$5,000.

The approximate incident rates for reported leaks meeting this criteria are summarized below:

Incident Rate (per 1,000 mile/years)	1.31
Injury Rate (per 1,000 mile/years)	.149
Fatality Rate (per 1,000 mile/years)	.017





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It's interesting to note that these results are essentially the same as those for reportable U.S. natural gas lines from 1970 through June 1984, which had a similar \$5,000 property damage reporting requirement.

Table 3-4  
**U. S. Hazardous Liquid Pipeline Accidents  
1986 - 1992**

	1986	1987	1988	1989
Total Pipeline Mileage	150,000	155,000	155,000	155,000
Number of Incidents	203	237	196	161
Incident Rate (Incidents/1000 Mile Years)	1.35	1.53	1.26	1.04
Number of Injuries	32	20	19	38
Injury Rate (Injuries/1000 Mile Years)	.213	.129	.123	.245
Number of Fatalities	3	3	2	2
Fatality Rate (Fatalities/1000 Mile Years)	.020	.019	.013	.013

	1990	1991	1992	Total
Total Pipeline Mileage	151,000	152,300	152,300	1,070,600
Number of Incidents	177	210	223	1,407
Incident Rate (Incidents/1000 Mile Years)	1.17	1.38	1.46	1.31
Number of Injuries	7	5	38	159
Injury Rate (Injuries/1000 Mile Years)	.046	.033	.250	.149
Number of Fatalities	3	0	5	18
Fatality Rate (Fatalities/1000 Mile Years)	.020	.000	.033	.017

NOTES: Mileage figure are approximate as reported by US Department of Transportation, Annual Report on Pipeline Safety, as published for each year. After October 21, 1995, reportable incidents include:

1. Explosion or fire not intentionally set by the operator
2. Loss of more than 50 barrels of liquid or carbon dioxide
3. Escape to the atmosphere of more than 5 barrels per day of highly volatile liquid
4. Death of any person
5. Bodily harm to any person resulting in loss of consciousness, necessity to carry the person from the scene, or disability which prevents the discharge of normal duties or the pursuit of normal activities beyond the day of the accident
6. Estimated property damage (operator's property or property of others, or both) exceeding \$5,000



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### 3.5 Summary of CSFM Regulated Hazardous Liquid Pipelines - 1981 through 1990

This study included all CSFM-regulated interstate and intrastate hazardous liquid pipelines. The systems included in this study had complete leak records. *All leaks, regardless of size, extent of property damage, or extent of injury were included in the study.* As a result, the incident rates were much higher than presented in earlier studies, which only included reported leaks fitting a relatively narrow criteria. A summary of these results is included in Table 3-5. The incident rates for *all* leaks, as well as those meeting the noted criteria, which occurred during the ten year study period are summarized below. (All financial data has been converted to \$US 1994; the incident rates corresponding to various dollar amounts has been estimated using the available data.)

Incident Rate - all leaks (per 1,000 mile years)	7.08
Incident Rate - all crude oil leaks (per 1,000 mile years)	9.89
Incident Rate - > \$1,000 (per 1,000 mile years)	5.80
Incident Rate - > \$10,000 (per 1,000 mile years)	3.64
Incident Rate - > \$100,000 (per 1,000 mile years)	1.36
Injury Rate - any severity (per 1,000 mile years)	.685
Fatality Rate (per 1,000 mile years)	.042



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Table 3-5A  
**CSFM Regulated Hazardous Liquid Pipeline Data - All Leaks**  
1981 through 1990

	1981	1982	1983	1984	1985	1986
Total Pipeline Mileage	6,482	6,658	6,675	6,835	7,005	7,501
Number of Incidents	53	83	53	30	45	46
Incident Rate (Incidents/1000 Mile Years)	8.18	12.47	7.94	4.39	6.42	6.13
Number of Injuries	0	1	2	0	0	15
Injury Rate (Injuries/1000 Mile Years)	.000	.150	.300	.000	.000	2.000
Number of Fatalities	0	0	0	0	0	1
Fatality Rate (Fatalities/1000 Mile Years)	.000	.000	.000	.000	.000	.133

	1987	1988	1989	1990	Total
Total Pipeline Mileage	7,587	7,600	7,609	7,610	71,563
Number of Incidents	60	52	42	43	507
Incident Rate (Incidents/1000 Mile Years)	7.91	6.84	5.52	5.65	7.08
Number of Injuries	0	0	31	0	49
Injury Rate (Injuries/1000 Mile Years)	.000	.000	4.074	.000	.685
Number of Fatalities	0	0	2	0	3
Fatality Rate (Fatalities/1000 Mile Years)	.000	.000	.263	.000	.042

NOTE: The above table includes all leaks, regardless of size or severity



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Table 3-5B  
**CSFM Regulated Hazardous Liquid Pipeline Data**  
**Leaks Greater than \$5,000 Damage**  
1981 through 1990

	1981	1982	1983	1984	1985	1986
Total Pipeline Mileage	6,482	6,658	6,675	6,835	7,005	7,501
Number of Incidents	52	73	44	30	41	40
Incident Rate (Incidents/1000 Mile Years)	8.05	10.96	6.59	4.39	5.85	5.33
Number of Injuries	0	1	2	0	0	15
Injury Rate (Injuries/1000 Mile Years)	.000	.150	.300	.000	.000	2.000
Number of Fatalities	0	0	0	0	0	1
Fatality Rate (Fatalities/1000 Mile Years)	.000	.000	.000	.000	.000	.133

	1987	1988	1989	1990	Total
Total Pipeline Mileage	7,587	7,600	7,609	7,610	71,563
Number of Incidents	48	42	35	36	441
Incident Rate (Incidents/1000 Mile Years)	6.33	5.53	4.60	4.73	6.16
Number of Injuries	0	0	31	0	49
Injury Rate (Injuries/1000 Mile Years)	.000	.000	4.074	.000	.685
Number of Fatalities	0	0	2	0	3
Fatality Rate (Fatalities/1000 Mile Years)	.000	.000	.263	.000	.042

NOTE: The above table includes all leaks which resulted in any injury, regardless of severity, and all leaks resulting in fatalities



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Table 3-5C  
**CSFM Regulated Hazardous Liquid Pipeline Data**  
**Leaks Greater than \$50,000 Damage**  
1981 through 1990

	1981	1982	1983	1984	1985	1986
Total Pipeline Mileage	6,482	6,658	6,675	6,835	7,005	7,501
Number of Incidents	39	56	33	20	31	27
Incident Rate (Incidents/1000 Mile Years)	6.02	8.41	4.94	2.93	4.43	3.60
Number of Injuries	0	1	2	0	0	15
Injury Rate (Injuries/1000 Mile Years)	.000	.150	.300	.000	.000	2.000
Number of Fatalities	0	0	0	0	0	1
Fatality Rate (Fatalities/1000 Mile Years)	.000	.000	.000	.000	.000	.133

	1987	1988	1989	1990	Total
Total Pipeline Mileage	7,587	7,600	7,609	7,610	71,563
Number of Incidents	34	30	21	26	317
Incident Rate (Incidents/1000 Mile Years)	4.48	3.95	2.76	3.42	4.43
Number of Injuries	0	0	31	0	49
Injury Rate (Injuries/1000 Mile Years)	.000	.000	4.074	.000	.685
Number of Fatalities	0	0	2	0	3
Fatality Rate (Fatalities/1000 Mile Years)	.000	.000	.263	.000	.042

NOTE: The above table includes all leaks which resulted in any injury, regardless of severity, and all leaks resulting in fatalities



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Table 3-5D  
**CSFM Regulated Hazardous Liquid Pipeline Data**  
**Leaks Greater than \$500,000 Damage**  
1981 through 1990

	1981	1982	1983	1984	1985	1986
Total Pipeline Mileage	6,482	6,658	6,675	6,835	7,005	7,501
Number of Incidents	36	50	30	19	28	21
Incident Rate (Incidents/1000 Mile Years)	5.55	7.51	4.49	2.78	4.00	2.80
Number of Injuries	0	1	2	0	0	15
Injury Rate (Injuries/1000 Mile Years)	.000	.150	.300	.000	.000	2.000
Number of Fatalities	0	0	0	0	0	1
Fatality Rate (Fatalities/1000 Mile Years)	.000	.000	.000	.000	.000	.133

	1987	1988	1989	1990	Total
Total Pipeline Mileage	7,587	7,600	7,609	7,610	71,563
Number of Incidents	31	24	18	24	281
Incident Rate (Incidents/1000 Mile Years)	4.09	3.16	2.37	3.15	3.93
Number of Injuries	0	0	31	0	49
Injury Rate (Injuries/1000 Mile Years)	.000	.000	4.074	.000	.685
Number of Fatalities	0	0	2	0	3
Fatality Rate (Fatalities/1000 Mile Years)	.000	.000	.263	.000	.042

NOTE: The above table includes all leaks which resulted in any injury, regardless of severity, and all leaks resulting in fatalities



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### 3.6 Data Summary of California Crude Oil Pipelines Under Study - 1993 through 1995

This study included all California crude oil liquid pipelines not previously regulated by any State agency.

The systems included in this study had complete leak records. Leak incidents of one barrel or more, or any spill onto water, or any spill which could threaten ground water were included in this study. The incident rates were very similar to the results for CSFM-regulated hazardous liquid pipelines. A summary of these results is included in Table 3-6. The incident rates for the leaks which occurred during the study period are summarized below.

Incident Rate - leaks > 1 bbl (per 1,000 mile years)	6.72
Incident Rate - > \$1,000 (per 1,000 mile years)	6.72
Incident Rate - > \$10,000 (per 1,000 mile years)	1.34
Incident Rate - > \$100,000 (per 1,000 mile years)	1.14
Injury Rate - any severity (per 1,000 mile years)	0.00
Fatality Rate (per 1,000 mile years)	0.00

Note: Financial data is shown in constant \$US 1994

Although the overall incident rates for this study were very similar to those recorded in the earlier CSFM-regulated hazardous liquid pipeline study (6.72 versus 7.08 incidents per 1,000 mile years), it's interesting to note that the incident rates for spills resulting in various amounts of damage were significantly lower, as indicated below.

Description	Crude Oil Pipelines Under Study	CSFM Regulated Pipelines
Incident Rate > \$1,000 Damage (per 1,000 mile yrs)	6.72	5.80
Incident Rate > \$10,000 Damage (per 1,000 mile yrs)	1.34	3.64
Incident Rate > \$100,000 Damage (per 1,000 mile yrs)	<b>1.14</b>	1.36
Incident Rate > \$1,000,000 Damage (per 1,000 mile yrs)	0.00	0.28

Note: Financial data converted to \$US 1994

This parameter will be reviewed in more detail later in this report. However, this result is reasonable, since the crude oil pipelines under study are generally much smaller in diameter and length, are primarily located in rural areas, and do not transport refined petroleum products.



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Table 3-6  
**California Crude Oil Pipelines Under Study  
1993 through 1995**

	1993	1994	1995	Total
Total Pipeline Mileage	494	496	496	1,486
Number of Incidents	1	4	5	10
Incident Rate (Incidents/1000 Mile Years)	2.02	8.06	10.08	6.72
Number of Injuries	0	0	0	0
Injury Rate (Injuries/1000 Mile Years)	.000	.000	.000	0
Number of Fatalities	0	0	0	0
Fatality Rate (Fatalities/1000 Mile Years)	.000	.000	.000	.000

NOTE: The above table includes all leaks >1 bbl

### 3.7 Comparison of Various Incident Data Sources

Table 3-7 demonstrates the differences that various reporting criteria have on the resulting incident rates.

It should be noted that the California incident rates, which appear to be much higher, *are the only data which have been completely audited*. These data do *not* necessarily indicate that California's pipeline network presents a higher risk than those in other areas. Unfortunately however, we could not find audited data from other areas, with complete leak records, for comparison.

One of the benefits of having data available which met various reporting standards was that incident rates could be established for a variety of criteria. For example, the CSFM-regulated hazardous liquid data could be used to establish incident rates for *all* leaks and injuries. Data from the other studies could be used to establish incident rates for their specific reporting criteria. These differences are summarized in the following subsection.





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Table 3-7  
**Comparison of Various Incident Data Sources**

	Incident Rate	Injury Rate	Fatality Rate
CONCAWE (1981-1994)	.850	.010	.030
US Natural Gas (1970-1984)	1.300	.096	.016
US Natural Gas (1984-1992)	.260	.061	.018
US Hazardous Liquid (1986-1992)	1.310	.149	.017
CSFM Regulated Pipelines-all leaks (1981-1990)	7.080	.685	.042
Calif Crude Oil Pipelines Under Study (1993-1995)	6.720	.000	.000
Calif Leaks >5 bbl or >\$5,000 (1981-1990)	3.360	.000	.000
Calif Leaks >\$50,000 (1981-1990)	.670	.000	.000

NOTE: The California regulated hazardous liquid pipeline data includes all leaks and injuries, regardless of severity. Further, California data was completely audited. The resulting California incident rates do not necessarily indicate that California crude oil and/or regulated hazardous liquid pipelines pose a higher risk than those included in other studies. The reader should consult the report text for more complete discussion.



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### 3.8 Uncorrected Pipeline Risks

Using the data developed in the prior subsections, one can estimate the incident rates for various pipeline events as follows:

Event	Incident Rate
Any size leak from CSFM regulated pipeline (per 1,000 mile years)	7.1
≥ 1bbl leak from crude oil pipeline under study (per 1,000 mile yrs)	6.72
Property damage >\$1,000 (per 1,000 mile years)	6.7
Property damage >\$10,000 (per 1,000 mile years)	1.3 to 3.6
Property damage >\$100,000 (per 1,000 mile years)	1.1 to 1.4
Property damage >\$1,000,000 (per 1,000 mile years)	0.0 to 0.28
Any injury (per 1,000 mile years)	0.0 to 0.70
Injury requiring hospitalization (per 1,000 mile years)	0.0 to 0.10
Fatality (per 1,000 mile years)	0.0 to 0.04

These values may be useful when evaluating the risks associated with proposed pipeline projects. However, as noted by the wide range of values presented, the user should use judgement in selecting the appropriate values for a particular project. Consideration should be given to the type of pipeline under investigation, the contents being transported, pipe age, type of coating, operating temperature, and other parameters. The data presented in Chapter 4 of this report, and the 1993 California Hazardous Liquid Pipeline Risk Assessment will aid the reader in making such assessments.